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Bulletin No. 205 - The Beet Leafhopper in Utah: A Study of Its Distribution and the Occurrence of Curly-top

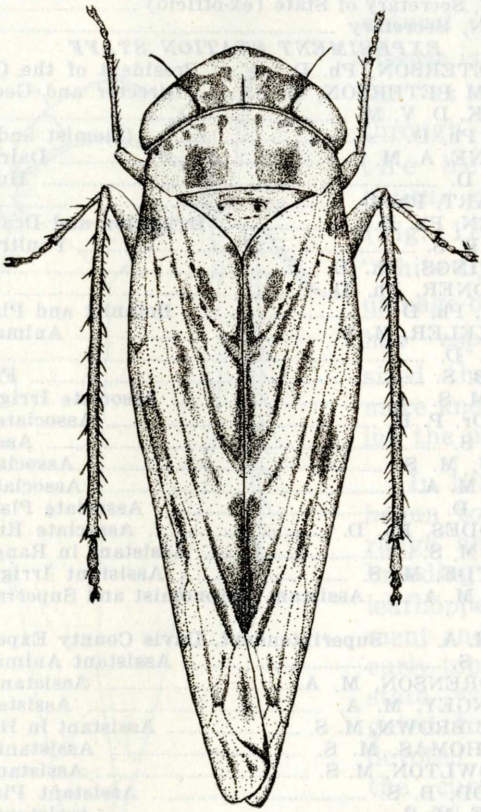
George F. Knowlton

BULLETIN 205 JUNE, 1928

The Beet Leafhopper In Utah

A Study of Its Distribution and the Occurrence of Curly-top

By GEORGE F. KNOWLTON



The dark form of the beet leafhopper,
Eutettix tenellus (Baker) (x30)

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THE BEET LEAFHOPPER IN UTAH

A Study of Its Distribution and the Occurrence of Curly-top

GEORGE F. KNOWLTON[1]

INTRODUCTION

The sugar-beet industry of Utah, and many other western states, has suffered enormous losses from curly-top. Under natural conditions this disease is transmitted, so far as known, solely through the feeding of the beet leafhopper, *Eutettix tenellus* (Baker) (Fig. 1), the so-called "white fly." The serious damage of 1924 and 1926 has especially emphasized the necessity for more knowledge concerning the problem.

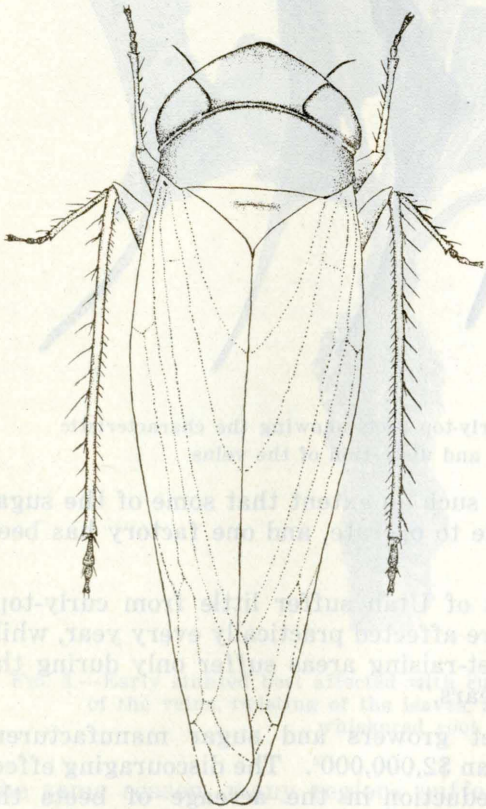

FIG. 1.—The light form of the beet leafhopper, *Eutettix tenellus* (Baker) (x30)

In 1925[2] studies were begun to determine the range and principal breeding grounds of the leafhopper. The development and damage of the curly-top disease in the state was also investigated. In 1924 the writer devoted some study to the curly-top outbreak and did some work in the beet fields again during the spring of 1925.

[1]The writer wishes to thank Mr. Walter Carter of the U. S. Bureau of Entomology, who is in active leadership of the cooperative project, for suggestions and help in outlining the work herein discussed. He also wishes to thank Director William Peterson and Dr. H. J. Pack of the Utah Station for suggestions and encouragement. The writer is indebted to Dr. E. G. Titus, formerly of the Utah-Idaho Sugar Company, for cooperation and suggestions. Credit is due also to many workers connected with the various

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ECONOMIC IMPORTANCE

The financial loss resulting from curly-top in Utah is probably greater than that caused by any other insect or plant disease affecting the sugar-beet. In fact, the disease has limited produc-

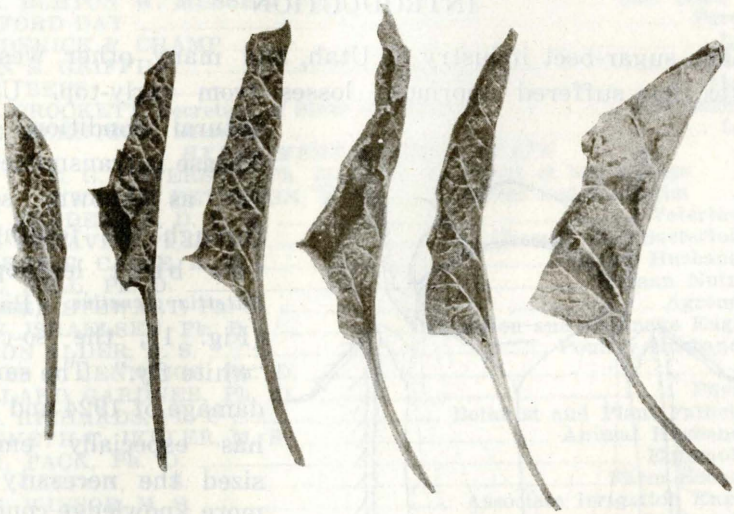

FIG. 2—Leaves from curly-top beets showing the characteristic roughening and distortion of the veins

tion in certain sections to such an extent that some of the sugar factories have been unable to operate, and one factory has been moved to another state.

Ordinarily most parts of Utah suffer little from curly-top; some sections, however, are affected practically every year, while many of the principal beet-raising areas suffer only during the so-called "bad curly-top years."

In 1924 the sugar-beet growers and sugar manufacturers suffered a loss of more than $2,000,000[3]. The discouraging effect of such a loss caused a reduction in the acreage of beets the following year. This decrease has been unfavorable to the

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sugar companies throughout the state who gave information valuable in obtaining a comprehensive knowledge of general conditions, and who frequently suggested situations of interest and importance in the work.

[2]Work on the beet leafhopper investigation was commenced August 1, 1925, under cooperative agreement with the Bureau of Entomology, U. S. Department of Agriculture and with the Idaho and Utah Agricultural Experiment Stations.

[3]Knowlton, G. F., 1927. The Beet Leafhopper and Curly-top Situation in Utah. Utah Agr. Expt. Sta. Circ. 65, pp. 3-12.

manufacturers, for during recent years even the maximum acreage has not produced sufficient beets to operate all of the Utah factories.

Beet-raising in northern Utah was very profitable during 1925, and high tonnage was common. In southern Utah, during

FIG. 3.—Early stunted beet affected with curly top, showing roughening of the veins, twisting of the leaves, and the characteristic whiskered root

the same season, many regions suffered from curly-top, some reporting as great damage as that of 1924.

Curly-top damage in 1926 was more severe than in 1924. The loss was so great that no factories were operated south of Spanish Fork and only a few carloads of beets were shipped to the factories farther north. Much of the southern area suffered a complete loss. While a better crop of beets was produced in the north, much of that area suffered greatly, some fields being plowed up or abandoned. Many fields were very much neglected,

but harvested if the crop was worth digging. Most of the beets in northern Utah were harvested, and about half of the factories in this area were operated.

Cache County probably suffered less than any other section of Utah during 1926. In this area, fields yielded from practically

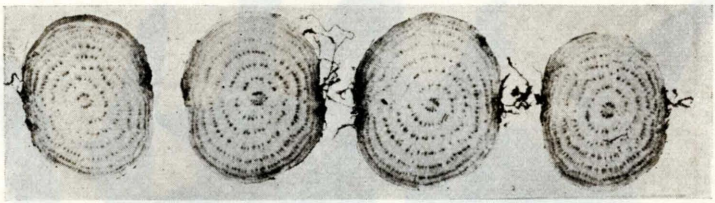

FIG. 4.—Cross-sections of curly-top beet root, showing the dark concentric rings due to the discoloration of the vascular bundles

nothing to 24 tons to the acre, with most fields producing from 7 to 10 tons. The Garland district, a few miles west across the mountains from Cache Valley, has long been one of the greatest beet-producing areas in the state; in this district, however, the beets averaged about 4 tons for each acre planted, or about 6 tons for each acre harvested.

Curly-top damage was generally distributed over the state in 1927, but ordinarily developed rather slowly, so that the beets in most areas had acquired fair size before the damage from the disease became severe. It would appear that a large percentage of the leafhoppers present during the spring were non-viruliferous, or undoubtedly considerably more early damage would have occurred. The leafhoppers were quite numerous in the fields from early spring, and more damage was expected than really occurred in many places throughout the state. Most parts of Cache County, the region from Fountain Green to Manti, parts of Boxelder, Weber, Davis, and Salt Lake as well as several other counties suffered comparatively little during this season, although on the whole other localities suffered moderate to severe damage. Early damage occurred at Monroe and some other parts of Sevier and Sanpete Counties, as well as in the vicinity of Lynndyl, Leamington, Delta, and some fields at Lehi.

Many of the fields around Delta, from which area the factory was moved in 1927, had such great numbers of beet leafhoppers present before thinning that some farmers doubted the possibility of raising a paying crop. Much damage did occur in this

area, but the crop turned out much better than would ordinarily have been expected, considering the large number of beet leafhoppers that were present in the fields at thinning time.

The curly-top situation became much worse toward late summer, resulting in considerable damage throughout most of Sanpete and Sevier Counties, at Lynndyl, Leamington, Delta, Grantsville, Lehi, Hooper, parts of Bear River City region, north and west of Ogden, at Thatcher, Bothwell, Penrose, and in occasional fields throughout the remainder of the beet-growing areas of Utah.

METHOD OF STUDY

Quantitative methods were adopted in order to give a basis for comparing the extent of the disease and the abundance of

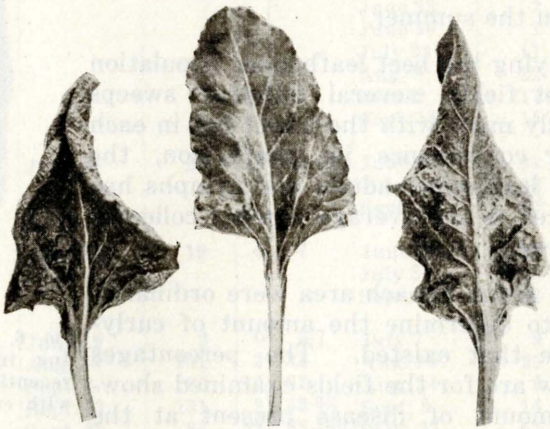

FIG. 5.—A normal sugar-beet leaf with a severely curled one on each side

the leafhoppers during different years and in different localities.

The percentage of disease on sugar-beets was obtained ordinarily by examining 100 beets in a cross-section of a field. If the amount of the disease in different parts of a field varied considerably, often two or more counts were made and these averaged. The percentage of curly-top is not always an index to the actual amount of damage because of the great variation in severity of disease in the infected plants. Variation in severity among different fields in any locality is frequently quite pronounced.

The population of the leafhoppers was determined by making a given number of sweeps over the plants with a standard American insect net. After making 50 or 100 sweeps, the leaf-

hoppers were killed and the numbers of adults and nymphs counted. However, if beets were very small determinations usually were made by examining 100 plants in a thinned row or each beet in 100 linear feet of an unthinned row.

SEASONAL DEVELOPMENT OF DISEASE

The tabulation which follows indicates, in a general way, the development of the disease on sugar-beets during the past two seasons. During the season of 1926 the damage was severe and beets were stunted at all stages. During 1927, although the leafhoppers were abundant from early spring, the beets usually obtained a good size before the disease became severe enough greatly to retard development. Extreme damage did not become widespread until late in the summer.

FIG. 6. — Vein-clearing in young leaf recently affected with curly-top.

In studying the beet leafhopper population in the beet fields, several hundred sweeps were usually made with the insect net in each area. For convenience in comparison, the number of leafhopper adults and nymphs has been reduced to the average number collected in 100 sweeps.

Several fields in each area were ordinarily examined to determine the amount of curly-top disease that existed. The percentages listed below are for the fields examined showing the amount of disease present at the time, and the range in percentage of disease between the field with the minimum and the field with the maximum amount of curly-top.

SEASONAL ABUNDANCE OF THE BEET LEAFHOPPERS AND THE OCCURRENCE OF CURLY-TOP ON SUGAR-BEETS

Locality	Date (1926)	Adult Leafhoppers	Nymphs	% Curly-top	Date (1927)	Adult Leafhoppers	Nymphs	% Curly-top
Amalga*	July 3	6	0	14	July 2	1	0	1
	Aug. 18	66	0	18	Sept. 10	9	1	2-5
	Sept. 23	16	6	16-24	Oct. 4	16	0	13
American Fork	June 23	8	0	14-27	July 12	11	3	12
	Sept. 6	38	6	88-100	Sept. 6	22	4	74
Angus*					June 9	2	0	1
					June 23	2	1	1
					June 30	1	1	3
					July 28	11	1	9
					Aug. 8	22	6	14
					Sept. 2	17	7	11-17
					Sept. 15	15	4	37-43
Austin*	June 25	20	2	24-49	June 27	38	21	11-24
					July 26	48	2	13-24
					Sept. 21	17	3	96-100
Axtell	June 24	19	4	7	June 28	34	16	14
					July 26	29	3	26
					Sept. 20	22	2	100
Bear River City	June 19	2	0	3-7	July 7	9	1	7-9
	Aug. 28	101	2	32	Aug. 10	25	2	3-19
	Sept. 3	76	10	62	Aug. 24	9	3	14-16
	Sept. 11	131	9	43-98	Sept. 3	14	3	36-94
	Sept. 25	85	52	68-100	Sept. 27	51	3	36-94
	Oct. 6	106	8	100				
	Oct. 16	43	5	100				
Benjamin*	June 24	24	4	18	July 27	27	2	13-16
	July 25	18	4	32				
Benson*	June 18	5	0	6	July 20	5	0	1
					Sept. 12	11	2	3-4
Bothwell*	Oct. 16	63	4	100	May 17	1**	0	0
					May 25	3**	0	0
					Aug. 24	9	1	9-61
					Sept. 3	22	5	67-72
					Sept. 27	16	2	22-97
Brigham	June 22	2	0	3	May 14	2	0	0
	July 31	87	23	19	June 17	4	1	1
	Aug. 28	123	12	18	Aug. 10	26	1	8
	Sept. 3	44	9	22	Sept. 22	6	1	16

*A locality without a postoffice.
**Count made on 100 linear feet of unthinned row.

Locality	Date (1926)	Adult Leafhoppers	Nymphs	% Curly-top	Date (1927)	Adult Leafhoppers	Nymphs	% Curly-top
Brigham	Sept. 18	64	12	69				
	Sept. 25	28	6	49-72				
Cache Junction					July 18	16	10	4-7
					Aug. 23	10	1	11-23
					Sept. 12	17	2	46-62
Clearfield	June 22	2	0	1-5				
					May 26	4**	0	0
					June 4	6**	0	1
					June 30	8	1	11
					Sept. 6	10	2	11-14
					Sept. 19	19	3	14
College Ward*	Aug. 21	42	1	6-56	May 17	2**	0	0
	Sept. 21	63	10	68-98	July 7	1	0	1
	Oct. 14	19	1	100	July 20	5	1	2
					Aug. 7	4	0	5
					Sept. 26	11	4	8-18
Collinston	June 19	5	0	18-24	Aug. 20	14	1	16
	July 31	78	10	67				
	Aug. 6	80	8	86				
	Sept. 11	84	4	88				
	Sept. 15	104	72	100				
Corinne	Sept. 3	24	0	85	Aug. 10	21	2	9
					Aug. 24	12	2	23-71
Cornish	July 5	6	1	7-8	May 13	1	0	0
	July 13	62	21	10-28	June 1	1*	0	0
	Aug. 5	44	3	13-56	Aug. 22	6	1	2-3
	Sept. 1	46	6	11-25	Oct. 4	13	2	11-14
	Oct. 22	15	0	46-56				
Delta	July 1	39	7	85-100	June 24	77	3	1
	July 20	30	6	98-100	July 27	71	2	28-83
					Sept. 21	24	3	61-94
Deweyville	July 31	37	4	22-28	Sept. 13	10	2	11-14
					Sept. 22	7	5	12-68
Draper	June 23	9	0	10	June 4	17**	0	1
	July 18	94	8	19	June 24	12	1	5
	Sept. 6	20	1	95-98	Aug. 12	18	1	11
					Sept. 6	13	2	67-73
					Sept. 19	24	5	68-83
Elsinore					June 27	32	16	13-17
					July 27	70	3	19-21
					Sept. 20	28	2	100
Farmington	June 22	12	0	4-8	May 27	12**	0	2
	July 16	14	3	14	June 4	10**	0	3

*A locality without a postoffice.
**Count made on 100 linear feet of unthinned row.

Locality	Date (1926)	Adult Leafhoppers	Nymphs	% Curly-top	Date (1927)	Adult Leafhoppers	Nymphs	% Curly-top
Farmington	Sept. 6	76	10	32-89	June 23	7	21	2-9
					June 30	5	2	11
					July 12	38	29	31
					July 25	51	6	34
					Aug. 12	11	0	67
					Sept. 6	20	5	74-96
					Sept. 19	28	4	78-100
Fielding	June 19	8	0	7-17	May 17	2	0	0
	July 31	44	6	28-32	June 21	13	2	2
	Aug. 20	80	1	88-96	July 7	8	1	3-11
	Sept. 18	41	9	98-100	Aug. 10	28	5	5-11
	Oct. 6	69	9	100	Aug. 20	19	1	18-38
	Oct. 16	36	2	100	Sept. 13	13	3	21-32
					Sept. 27	20	4	78-81
Five Points*					May 14	5**	0	0
					May 23	19**	0	0
					June 2	7**	0	2
					June 17	4	6	5
					Aug. 8	24	3	34
					Aug. 18	17	6	61
					Sept. 15	22	13	96
					Oct. 15	28	4	87-98
Garland	June 19	10	0	15-20	May 17	1	0	0
	July 31	30	1	12-26	June 21	10	0	1
	Aug. 28	231	28	42	July 7	12	0	3-6
	Sept. 3	39	2	36-68	Aug. 10	30	5	5-16
	Sept. 18	20	5	94-100	Aug. 24	9	4	13
	Sept. 25	16	2	67-100	Sept. 3	21	6	21-38
	Oct. 6	82	8	97-100	Sept. 13	14	4	14-28
	Oct. 30	6	0	100	Sept. 27	22	2	16-96
Grantsville	July 17	36	4	21	Aug. 13	105	11	97-100
Gunnison					June 21	8	4	10
					July 26	43	5	16-47
					Sept. 20	14	2	99-100
Honeyville	July 31	70	8	42	June 17	5	1	3
	Sept. 11	44	5	14-84	July 7	13	5	2-19
					Sept. 3	10	2	9-27
					Sept. 22	14	7	32-93
					Sept. 27	15	1	15-93
Hooper					June 9	7**	0	1
					Aug. 8	13	2	13-16
					Sept. 15	39	6	71-98
					Oct. 11	21	1	85-100
Hyde Park	June 10	11	2	9	May 13	1**	0	0
	Aug. 5	71	4	12	June 1	1**	0	0

*A locality without a postoffice.
**Count made on 100 linear feet of unthinned row.

Locality	Date (1926)	Adult Leafhoppers	Nymphs	% Curly-top	Date (1927)	Adult Leafhoppers	Nymphs	% Curly-top
Hyde Park	Aug. 18	110	18	12	June 16	1**	0	1
	Sept. 1	116	0	14	Aug. 22	9	1	6-8
	Sept. 9	45	4	9-18	July 29	5	0	3
	Sept. 15	33	1	9-24	Oct. 4	15	3	11-16
	Sept. 23	12	2	58				
Hyrum	June 17	2	0	0	May 12	1**	0	0
	July 5	6	0	7	July 16	13	5	1
	July 15	26	6	13	Aug. 17	7	2	2
	Sept. 2	98	5	6-14	Oct. 6	4	1	8
					Sept. 17	9	3	7
Layton	June 22	4	0	3-6	May 8	14	0	0
	July 16	10	0	10	May 27	4**	0	2
	Sept. 6	48	6	18	June 13	15**	1	1-3
					June 23	6	7	4
					July 25	32	5	12
					Sept. 6	19	3	31
					Sept. 19	20	2	43-88
Leamington					Sept. 21	48	4	100
					May 3	1**	0	0
Lehi	June 23	6	0	1-10	June 12	21	1	4-34
	July 18	166	22	11-19	July 6	42	14	12-35
	Sept. 6	94	16	83-98	July 12	13	7	4-48
					July 25	29	4	4-68
					Aug. 12	23	3	8-97
					Sept. 6	17	4	48-100
					Sept. 19	16	2	56-100
Lewiston	June 16	5	0	1-4	May 13	1	0	0
	July 3	9	1	4-12	June 16	2	0	1
	July 13	22	9	8-11	July 2	2	1	1-2
	Aug. 5	99	4	17	July 29	15	4	7-12
	Aug. 18	102	3	11-18	Aug. 22	7	1	4-19
	Sept. 1	68	3	9-36	Sept. 10	6	0	3-12
	Sept. 15	39	5	5-97	Oct. 4	15	1	3-18
Logan	June 17	4	0	1-5	May 17	1	0	0
	July 3	10	1	10-26	May 31	2	0	0
	July 31	22	2	10-31	June 21	1	0	1
	Aug. 10	56	7	35-63	July 2	4	2	2
	Aug. 18	71	6	11-85	July 7	7	1	2
	Aug. 21	57	1	23-85	July 29	4	0	2
	Sept. 2	67	5	17-85	Aug. 22	7	1	1-5
	Sept. 8	67	5	26-94	Aug. 31	7	0	4-14
	Sept. 14	62	4	17-64	Sept. 10	6	2	2-6
	Sept. 21	39	7	19-100	Oct. 4	7	2	9-12
Lynndyl	July 1	17	2	43-60	July 27	60	2	98-100
					Sept. 21	92	6	100

*A locality without a postoffice.

**Count made on 100 linear feet of unthinned row.

Locality	Date (1926)	Adult Leafhoppers	Nymphs	% Curly-top	Date (1927)	Adult Leafhoppers	Nymphs	% Curly-top
Mendon	Sept. 21	30	6	16-38	June 21	1	1	1
					Aug. 20	13	3	3-5
					Sept. 3	5	1	3-5
					Sept. 27	15	3	3-16
Millville	Aug. 17	82	12	27	May 3	1**	0	0
	Sept. 2	107	6	23-53	June 8	2**	0	1
					June 21	7	2	2
					July 8	11	2	3
					Aug. 13	14	6	3
					Aug. 30	10	3	6-82
					Sept. 8	10	2	5-87
					Sept. 26	11	2	9-96
Monroe	June 25	15	1	30-96	July 26	85	2	94-100
					Sept. 20	19	5	100
Murray	June 22	6	0	4-11	May 26	34**	0	0
	July 18	26	10	32	June 4	14**	0	2
	Sept. 6	32	5	37-84	June 23	9	7	5
					Sept. 6	23	6	24-83
					Sept. 19	19	4	32-82
North Ogden*					May 14	7**	0	0
					June 2	26**	0	1
					June 9	18	1	2
					June 23	9	7	4-9
					July 12	20	6	5-24
					July 28	14	1	32-68
					Aug. 8	12	0	11-62
					Aug. 18	18	0	47-68
					Sept. 2	21	10	68-94
					Sept. 15	17	8	76-99
					Sept. 28	21	7	82-100
					Oct. 15	25	3	84-100
Ogden	Sept. 6	178	15	43-91				
	Sept. 11		14	46-96	May 17	16**	0	0
					June 2	21	1	1
					June 23	15	1	1
					June 3	9	6	10
					June 30	13	23	17
					July 28	22	1	1
					Aug. 8	47	4	32
					Aug. 18	24	3	62
					Sept. 2	25	6	9-62
					Sept. 15	22	6	24-83
Plain City*								
					May 14	5	0	0
					June 2	3**	0	1
					June 23	7	5	2
					Sept. 2	71	32	16-98
					Sept. 28	13	5	42-100

*A locality without a postoffice.

**Count made on 100 linear feet of unthinned row.

Locality	Date (1926)	Adult Leafhoppers	Nymphs	% Curly-top	Date (1927)	Adult Leafhoppers	Nymphs	% Curly-top
Pleasant Grove	June 23	11	0	4	June 12	17**	0	1
	Aug. 23	16	0	17	July 6	12	1	7
	Sept. 6	64	6	97	Sept. 6	11	2	73
Portage	Aug. 20	79	3	96	Aug. 20	18	1	57
Provo	June 23	7	0	3-16	June 12	9**	0	1
	Aug. 23	47	4	36-98	June 24	35	23	4-21
	Sept. 6	68	7	41-100	July 12	16	3	5-99
					July 25	36	10	12-98
					Aug. 12	11	1	6-84
					Sept. 6	14	2	21-98
					Sept. 19	17	4	17-100
Richfield	June 24	10	0	24-73	June 27	20	19	8-18
					July 26	51	2	12-19
Richmond	June 3	6	0	12	Sept. 21	12	2	67-97
	July 3	7	1	8-14	May 13	1**	0	0
	July 10	6	1	9-13	June 1	2**	0	0
	Aug. 18	25	1	6-19	July 2	1	1	0
	Sept. 9	58	2	12-19	July 29	4	1	2-5
	Sept. 15	44	4	18	Oct. 4	8	0	4-7
	Sept. 23	22	4	14-24				
	Sept. 29	16	4	27				
Riverdale*	July 16	18	4	8	May 23	5**	0	0
	Sept. 11	98	4	58-97	June 17	2	1	2
					June 23	6	8	2
					July 12	9	3	2-4
					Sept. 2	22	5	8-12
Riverside	July 31	22	1	26-48	May 17	1	0	0
	Sept. 11	76	6	97	July 7	13	1	4
	Sept. 18	38	4	27-100	Aug. 8	17	2	7-12
	Oct. 6	20	4	78-100	Aug. 20	14	0	8-22
	Oct. 16	28	8	82-100	Sept. 3	15	5	9-31
					Sept. 27	21	1	16-34
					June 17	1	1	1
Roy					June 30	3	0	5
					July 28	17	2	8
					Aug. 8	15	1	16-21
					Sept. 15	20	4	26-38
					June 27	61	16	12-20
Salina	June 24	17	4	15-34	July 26	32	2	8-21
					Sept. 20	14	2	89-100
Salt Lake City	June 22	9	0	4-12	June 12	14	1	1
	July 16	17	2	14	June 23	9	7	5
	July 26	16	6	18	Aug. 12	14	6	12-72
					Sept. 6	17	5	52-74
					Sept. 19	24	5	63-96

*A locality without a postoffice.

**Count made on 100 linear feet of unthinned row.

Locality	Date (1926)	Adult Leafhoppers	Nymphs	% Curly-top	Date (1927)	Adult Leafhoppers	Nymphs	% Curly-top
Santaquin	July 25	46	0	67	July 26	39	7	8
					Sept. 20	43	9	87
Sigurd	June 24	4	0	23-39	June 28	51	30	6-14
					July 26	96	6	17
					Sept. 20	12	2	84-93
Smithfield	June 16	5	0	1	June 16	1	0	1
	July 3	12	0	16-31	July 29	3	5	4
	July 16	11	3	8-14	Oct. 4	9	1	5-8
	Aug. 18	70	4	5-17				
	Sept. 15	18	2	8-64				
	Sept. 23	10	0	21				
Spanish Fork					May 3	2	0	0
					June 24	7	4	8
					July 26	37	7	5-12
					Sept. 20	16	5	18
Thatcher*	Oct. 16	84	2	100	May 17	2	0	0
					June 21	5	1	1
					Aug. 24	10	4	17-82
					Sept. 3	34	9	82
					Sept. 27	16	2	64-90
Tremonton	July 6	12	2	19	May 17	2	0	0
	July 31	64	3	17-33	June 1	2	0	0
	Aug. 28	264	16	34-53	June 21	3	1	1
	Sept. 3	64	0	21-73	July 7	7	0	4
	Sept. 11	70	12	24-83	Sept. 3	16	4	34
	Sept. 18	39	4	32-100	Sept. 27	14	3	42
	Sept. 25	81	29	96-100				
	Oct. 6	66	9	98-100				
	Oct. 16	44	1	96-100				
Trenton	Aug. 18	78	4	19	Oct. 4	12	2	13
	Sept. 1	59	6	15-48				
	Sept. 15	24	0	12-96				
	Sept. 29	34	8	62				
Wellsville	July 16	14	2	7	June 7	1	0	1
	Sept. 3	48	3	5-12	July 7	2	1	2
	Sept. 18	24	3	5-22	Aug. 24	12	1	11
Willard	Sept. 11	48	6	20-43	May 14	2	0	0
					June 9	9	0	2
					June 17	5	2	11
					July 5	13	2	14
					July 9	13	3	16
					Aug. 18	17	2	32
					Sept. 2	15	12	23-62
					Sept. 15	16	4	27-82
					Oct. 11	14	3	38-88

*A locality without a postoffice.

**Count made on 100 linear feet of unthinned row.

DISTRIBUTION

The survey of the range and breeding areas of the beet leafhopper, while not entirely complete, shows that this insect is distributed over practically all of the lower areas studied where

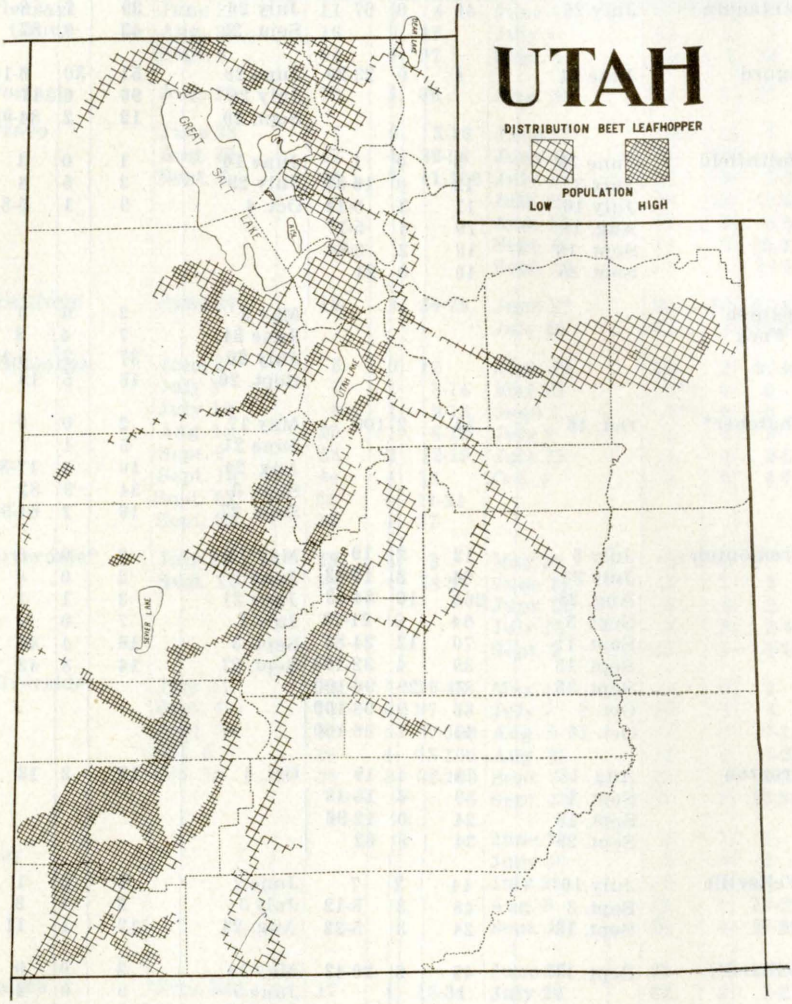

FIG. 7.—Map showing the distribution and comparative abundance of the beet leafhoppers in the parts of Utah studied during this survey

suitable host plants are present (Fig. 7). It is frequently encountered in higher areas on warm slopes where such weeds as Russian thistle and species of saltbushes are found. Russian thistle generally "comes in" wherever ground has been broken,

and even encroaches on the sagebrush, rabbit brush, greasewood, and shadscale areas.

The survey shows that in Utah the Russian thistle is the most common host for *E. tenellus*. This plant covers many hundreds of thousands of acres of deserted farms, deserts, roadsides, and fence rows and even invades cultivated fields. The saltbushes as a group (*Atriplex* spp.) probably rank next in importance as a host, with the sugar-beets following.

The leafhoppers seem to breed wherever found. The highest populations were usually found on deserted and abandoned dry-farm areas where large tracts of land are covered with Russian thistle. The more important breeding areas are Uintah Basin, Skull Valley, and many other parts of southern Utah such as the Escalante Desert, as well as the area west of Snowville.

The darkly shaded portions of the map (Fig. 7) correspond in general to the principal breeding areas of the beet leafhopper, with the exception of the sugar-beet-growing areas north of Utah Lake. In northern Utah there are few important breeding areas near beet-growing districts.

Beet leafhoppers and curly-top have been found in all the beet-growing areas of the state which have thus far been examined. The survey included almost every beet area except that in the vicinity of Green River, Utah.

The map of distribution (Fig. 7) shows the areas in which the beet leafhopper has been collected in the course of the survey. The range of the leafhopper undoubtedly extends into many other areas not indicated on the map. In general, beet leafhoppers were scarce or absent on the mountainous areas examined, except where ground had been broken for roads or farms. With the introduction of Russian thistle and other suitable host plants, the leafhoppers usually appear. Many areas of Utah will undoubtedly support more leafhoppers as weeds, beets, and other choice plants become more abundant.

LOCALITIES FROM WHICH THE BEET LEAFHOPPER HAS BEEN COLLECTED

In addition to the localities given under seasonal development of the disease, beet leafhoppers have been taken on sugar-beets in the vicinity of the following places:

Angus*	Centerfield	Clinton*
Aurora	Centerville	Clover
Blacksmith Canyon (mouth)*	Central	Cove*
Bountiful	Charleston	East Garland*
	Chester	Eden

*A locality without a postoffice.

Elwood*
Ephraim
Far West*
Fountain Green
Geneva*
Goshen
Harrisville*
Hinckley
Holden
Hot Springs*
Hoytsville
Huntsville
Joseph
Kanesville*
Kaysville
Knightsville*
Lakeview*
Madsen*
Magna
Manti
Mapleton*
Marriot*
Midvale
Mona
Morgan
Moroni
Myton
Nephi
Newton
Oasis
Orem*
Payson
Penrose*
Perry*
Petersboro*
Providence
River Heights*
Riverton
Salem
St. John
Sandy
Saratoga*
Sevier
Slaterville
Springville
Sugarhouse
Sugarville*
Sunset*
Sutherland*
Syracuse
Taylor*
Torrey
Venice
Vermillion*
Wellington
West Jordan*
West Weber*
Wilson*
Woodro*
Woods Cross

Beet leafhoppers have also been collected on table-beets at Garden City and on mangels at Laketown, Leeton, and Fort Duchesne.

The beet leafhopper has been collected on host plants, other than beets, from the following named localities[4]:

Abraham
Alton
Arthur*
Beaver
Beaver Dam*
Bennett*
Black Rock
Blue Bench*
Blue Creek
Brigham Canyon*
Bryce Canyon*
Burbank*
Capital Reef*
Castle Dale
Castlegate
Cedar*
Cedar Valley
Champlin*
Circleville
City Creek Canyon*
Clarkston
Clawson*
Clear Creek Canyon (mouth)*
Cold Creek Canyon (mouth)*
Dinosaur National Monument* (Uintah Basin)
Duchesne
Dry Lake*
Dugway Mountains*
Dyer*
Echo Canyon*
Elberta
Elwell*
Emery
Enterprise
Eureka
Fairfield*
Ferron*
Fillmore
Fisher's Pass*
Fish Spring*
Five-Mile Pass*
Frisco
Fruita*
Fruitland
Gandy
Garfield
Garrison
Glendale
Granite Creek*
Greenwood
Gunlock
Harold*
Hatch
Hatton (and S. W.)
Haw Bush*
Heiner
Helper
Henefer
Highland Drive*
Hill Creek*
Holden
Holliday*
Howell
Huntington
Hurricane
Indian Canyon*
Iosepa
Irontown*
Jensen
Jericho*
Johnson
Juab
Junction
Kanab
Kanarraville
Kanosh
Kanosh Canyon*
Kanosh Flats*
Kelton
Kingsville*
Kosmo (7 mi. E.)*
Lapoint
Leeds
Levan
Logan Canyon*
Lookout Pass*

[4]Many hundreds of collections have been made from areas without names. These regions are shown on the map.

*A locality without a postoffice.

Low*
Lund*
Marjun Pass*
Marysvale
McCormick
McIntyre*
Meadow
Milford
(and SW to Lund)
Mill Creek Canyon*
Mills
Modena
Mounds*
Mount Carmel
Mount Pleasant
Naples*
New Castle
Nioche*
North Salt Lake
Ogden Canyon*
Ophir
Orderville
Orton*
Ouray
Paragonah
Park City
Park Valley
Parley's Canyon*
Parowan
Pilot Spring*
Pinto
Plymouth
Promontory
Provo Canyon*
Randlett
Read*
Red Buttes Pass*
Redmond
Rockville
Roosevelt
Rosette
St. George
Santa Clara
Sardine Canyon*
Sawtooth*
Scipio
Silver City
Simonds Ranch*
Skull Valley*
Snowville
Soldier Summit
Spring City
Springdale
Spry
Stockton
Sulphurdale
Summit
Thistle
Timpie (3 miles S.)*
Tooele
Toquerville
Tridell
Troutcreek
Uintah*
Vernal
Vernon
Veyo
Virgin
Vivian Park*
Wanship
Washakie
Washington
Wellsville Canyon*
Whiterocks
Willow Creek*
Zion National Park

HOST PLANTS OF THE BEET LEAFHOPPER IN UTAH

With the advent of agriculture great areas of native plants were destroyed. To the native vegetation was added the Russian thistle, sugar-beets, and many other food plants which the leafhopper readily accepted. When great areas of the country became covered with such plants, one of the greatest natural checks on the leafhopper, i. e., the struggle for food, very largely was removed. Removal of this check upset the balance of nature with serious results to the sugar-beet industry. In many areas where but few leafhoppers could formerly live on the native vegetation, great numbers now develop on the introduced weeds. The area between Milford and Lund furnishes a striking example of this. In this one area alone, Russian thistle now covers thousands of acres of abandoned farm lands and supports enormous swarms of leafhoppers each year. At the present time the greatest number of beet leafhoppers in Utah are breeding on introduced host plants, particularly on the widely distributed weeds. At certain seasons most of the introduced weeds dry up, and at such times the native plants aid greatly in carrying the leafhoppers over until a better host plant is found, or until time to hibernate in the fall. If a suitable host plant is not found within a short time after the leafhoppers are forced to leave their former food plant, death will result. Undoubtedly

*A locality without a postoffice.

great numbers of leafhoppers are lost in the change from the drying weeds to suitable new plants.

The following list includes all of the host plants upon which the beet leafhopper has been collected during this survey. Additional work will undoubtedly add to the list. Particular study has been made of the common and more widely distributed plants, such as the Russian thistle, beet and saltbushes. In the northern part of Utah filaree seems to be used very little by the beet leafhoppers, even where large areas exist (such as that between Farmington and Provo). In most instances where greasewood and shadscale have been swept, no beet leafhoppers were taken.

GOOSEFOOT FAMILY	CHENOPODIACEAE
Alkali blight	*Suaeda moquinii* (Torr.) A. Nels.
Allscale	*Atriplex polycarpa* (Torr.) Wats.*
Beets	*Beta vulgaris*
Greasewood	*Sarcobatus vermiculatus* (Hook) Torr.*
Lamb's-quarters	*Chenopodium album* L.
Lenscale	*Atriplex lentiformis* (Torr.) Wats.*
Moundscale	*Atriplex nuttalli* Wats.*
Prostrate alkali blight	*Suaeda depressa* (Pursch) Wats.
Redscale, red orache	*Atriplex rosea* L.
Ribscale	*Atriplex powelli* Wats.*
Russian thistle	*Salsola pestifer* A. Nels.
Shadscale	*Atriplex confertifolia* (Torr. Frem.) Wats.*
	Chenopodum leptophyllum (Moq.) Nutt.*
AMARANTH FAMILY	AMARANTHACEAE
Pigweed	*Amaranthus retroflexus* L.
Prostrate pigweed	*Amaranthus blitoides* Wats.*
Tumbleweed	*Amaranthus graecizans* L.*
MUSTARD FAMILY	CRUCIFERAE
Black mustard	*Brassica nigra* (L.) Koch*
Cabbage	*Brassica oleracea**
Green tansy mustard	*Sophia filipes* (Gray) Heller
Treacle mustard	*Erysium cheivanthoides* L.*
Tumbling mustard	*Sisymbrium altissimum* L.
BUCKWHEAT FAMILY	POLYGONACEAE
Curled dock	*Rumex crispus* L.
Knotweed, knotgrass	*Polygonum aviculare* L.
NIGHTSHADE FAMILY	SOLANACEAE
Common nightshade	*Solanum nigrum* L.
Potato	*Solanum tuberosum**
Tomato	*Lycopersicon esculentum**
Wild tomato	*Solanum triflorum*
GOURD FAMILY	CUCURBITACEAE
Hubbard squash	*Cucurbita maxima**
Muskmelon	*Cucumis reticulatus**
Pumpkin	*Cucurbita pepo**
Watermelon	*Citrullus vulgaris**
PEA FAMILY	LEGUMINOSAE
Field and garden beans	*Phaseolus vulgaris**
GERANIUM FAMILY	GERANIACEAE
Red stem filaree (or stork's bill)	*Erodium cicutarium* L. Her.

*Plants from which the beet leafhopper has only been taken occasionally or in small numbers.

MALLOW FAMILY	MALVACEAE
Cheeseweed	*Malva rotundifolia* L.
CONVOLVULUS FAMILY	CONVOLVULACEAE
Wild morning glory	*Convolvulus arvensis* L.*
COMPOSITE FAMILY	COMPOSITAE
Giant ragweed	*Ambrosia trifida* L.*
Head lettuce	*Lactuca sativa**
Poverty weed	*Iva axillaris* Pursh
Rabbit brush	*Chrysothamnus nauseosus* (Pallas)*

LIFE HISTORY NOTES ON THE BEET LEAFHOPPER

The life history of this insect has not been completely worked out in Utah, but collection data indicate that at least two broods are produced annually in most parts of the state. Nymphs are most abundant in spring and late summer; they are present in smaller numbers throughout the summer and fall. Some nymphs go into hibernation, but it is doubtful if any other than

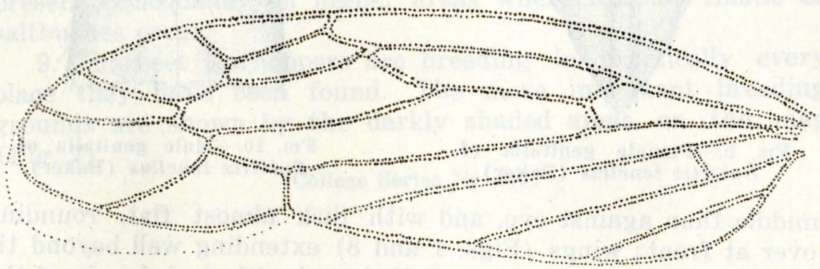

FIG. 8.—Front wing of *Eutettix tenellus* (Baker) showing the characteristic venation

adults are successful in passing the winter, particularly in the colder parts of Utah. South of Monroe, where all stages of nymphs were numerous on the Russian thistle, a large part of the first generation was found to be adult by the end of June, 1926. Most of the nymphs on sugar-beets were small at this time, although a few were one-half to three-fourths grown. At this time around Richfield the eggs, often with the red eyes of the embryos showing through the thin tissues of the beet leaf petiole, were abundant. There were also great swarms of young nymphs present at Venice and throughout most of Sevier County. The adults were numerous on beets from early spring in 1927 and generally abundant and widespread during the summer and fall of 1926 and 1927.

*Plants from which the beet leafhopper has only been taken occasionally or in small numbers.

DESCRIPTION OF BEET LEAFHOPPER,
EUTTETIX TENELLUS (BAKER)

Adult female.—Size 3.5 to 3.7 mm. long, and nearly 1 mm. wide; color whitish to greenish, and sometimes with darker blotches (cover cut); vertex short, rounding, slightly longer at

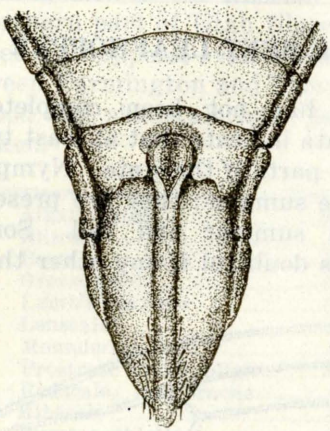

FIG. 9.—Female genitalia of *Eutettix tenellus* (Baker)

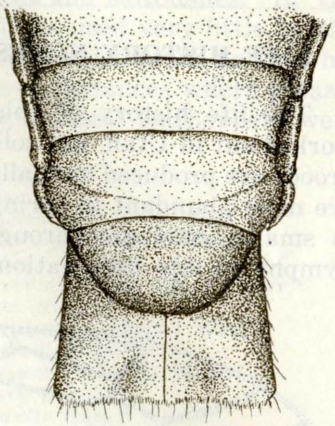

FIG. 10.—Male genitalia of *Eutettix tenellus* (Baker)

middle than against eye, and with disk almost flat, rounding over at front; wings (Figs. 1 and 8) extending well beyond tip of abdomen (Fig. 9), closely folded, and with dark bands of the tergum often showing through.

Adult male.—Slightly smaller than female, with valve large, wider than long, roundly truncate (Fig. 10).

Nymphs.—General body form as in adults. Color varies from white, particularly in first and second instar nymphs, to greenish-white with banded or saddle-shaped markings of black, brown, and red on the thorax and abdomen of older nymphs.

SUMMARY

1. Severe curly-top damage discourages the planting of beets, often reducing the acreage planted. The maximum crop during recent years has not been sufficient to warrant the operation of all the factories now existing in Utah.

2. The beet crop in northern Utah in general was very good during the season of 1925.

3. Sugar-beets suffer more frequently, and often more severely, in the southern valleys of Utah than in the northern part of the state.

4. The beet crop was almost a complete failure in southern Utah during 1926, and the rest of the state had less than half of an average crop. Cache County suffered less than any other area in the state.

5. Curly-top damage was generally distributed over Utah during 1927, but the damage was seldom severe until toward the end of the season.

6. Considerable late injury occurred in Utah during 1924, 1926, and in some localities during 1927.

7. The beet leafhopper is commonly present in all of the sugar-beet growing areas of Utah at least during the summer season. Curly-top has also been observed in nearly all of these areas.

8. Beet leafhoppers have been found in all of the farming areas examined in the state and in practically every other place where its common host plants occur. It is abundant on abandoned farms and is widely distributed on several deserts, being present occasionally on higher areas where Russian thistle or saltbushes occur.

9. The beet leafhoppers are breeding in practically every place they have been found. The more important breeding grounds are shown by the darkly shaded areas on the map (Fig. 7).

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